

usually expected is the end of May or the beginning of June. The really critical months in North-Western India are August and September. If the rainfall is then abundant and continuous up to the end of the third week in September, with a final shower or two at the end of the month, all may yet be well; but if the rainfall of these months is light and partial, and if it ceases prematurely, the crops form no ear, and they perish and dry up in the warm dry west winds that speedily follow. And it is these crops that furnish the food staples of the agricultural classes of India.

H. F. B.

PHYSICAL SCIENCE FOR ARTISTS.¹

II.

WE next come to the absorption of light. I do not know whether you have had any opportunity yet in your laboratory course of observing the spectral phenomena produced when white light, or say solar light, is absorbed by different substances. The white light is broken up by the dispersion of the prisms into a rainbow band; while it is possible, by one means or another, one substance or another, to filch out of this coloured band some of the constituent colours, now at one end, now at another, sometimes in different parts at once; and when this has been done, the light which finally reaches the eye may be of any colour, as is evidenced by the different colours you see in a stained glass window. This is what happens also by the absorption of our atmosphere, due in all probability in great part to the contained aqueous vapour. The sun is white in the middle of the day and red at sunset. The blue part of the light, which, when all the colours reach us, looks white, has been taken away, and practically nothing but red is left; only certain parts of the spectrum are left. It is easy, after two or three hours' experiments with the absorption of light by different media, to grasp the laws which govern sunset colours precisely, as it is easy in the anatomical school to study the facts relating to the human form, particular muscles and the like. A diligent student will thus have the world of colour at his feet. This can, however, only be done by one interested in physical science, and I think it should be done by anyone who wishes to deal with landscapes or seascapes, anything, in fact, which has to do with the natural world. The results obtained in this way of course come to us pictorially, chiefly in the colour of sky and water and in the colours of clouds, and they are mixed up in pictures by the knowledge, or want of knowledge, of the artist who paints these various reflecting surfaces. The reflecting surface, whether water or cloud, or what not, must not only be true in colour, but perfectly formed, in order to give an absolutely perfect and pleasant picture.

Here I think it is that the need of physical science is greatest, and I do not know, in fact, that there ought not to be some kind of an examination in a College like this which shall insure that anyone who is going to take up the study of art is not colour-blind. This is done in the case of sailors and engine-drivers, and I think it should be done in the case of artists. There are pictures which have apparently been painted by colour-blind people; and of course it should be a subject of great regret that so much skill has been wasted in consequence of such a malformation as this.

It may be, of course, that in some cases, where the thing may be charitably supposed to arise from a physical defect, it is the result of mere ignorance, or want of observing power; but if that be so, then my point is proved, because it is clear that a good scientific training will cause these objectionable, impossible, colours to be gradually eliminated from our exhibitions. On the other hand, when we look at a gallery of pictures, one is so frequently

rewarded by the exquisite truth of some of them, that one could very well look over the defects of others, if all thoughts of the possible progress of art achievement were banished from one's mind.

Some of you may perhaps have read Mr. Ruskin's chapter on clouds. The scientific basis of the various cloud forms, however, you will not find there. Now when we consider that in land- and sea-scapes the sky, and especially the clouds, are among the most important reflectors of light, whether white or coloured, the form of the cloud is absolutely of very high importance. If the light is reflected by an absolutely impossible cloud, your delight at the colour, which may be true, is absolutely checked by the treatment of the anatomy of the cloud. Here, again, we touch a distinct branch of physical science. An acquaintance with the various forms of condensation assumed by aqueous vapour under the various conditions of the atmosphere would certainly keep one right where one would be very apt to go wrong. I referred, also, to the reflection of sunlight, whether white or coloured by absorption, by water. Here, I think, is a region where physical science is also helpful. There can be no question that the grandest display of colour in the natural world is a sunrise or sunset, either at sea, or where there is a water surface to bring in a second series of reflection phenomena. As a rule, perhaps, if the water be somewhat land-locked, or at all events not broken up by strong wind, the effect is finer, and this perhaps is one of the reasons, but only one, why the sunsets seen off the west coast of Scotland are so remarkable.

This, however, does not always hold. I have seen a sunrise in the Mediterranean when passing the Straits of Gibraltar twenty years ago, which was so magnificent, that not only is it still present in my mind's eye, but all the sailors who were swabbing the deck at the time ceased work and simply gazed at it entranced. It promised to be a cloudy sunrise, but suddenly the cloud pall melted into mackerel sky, and the sun at rising payed out different colours on the high and low patches; the sea was choppy, and every facet of every wave, and every facet of a facet, being turned to different parts of the sky; these picked up and reflected to the eye different colours, so that every wave looked like a casket of gems.

The red or yellow colours on the clouds depend simply upon the thickness of the atmosphere which the sunlight has traversed to reach them; the colour depends absolutely upon the light received from the sun, and it has nothing to do with the apparent angular distance from the sun in your picture; but while all this change is going on in the clouds the sky itself will be zoned above the horizon from the red to the blue overhead, and in addition to that, you will get the greater luminosity nearer the sun's place. But further than that the sky will not go, because it cannot. At the same height above the horizon you must have absolutely the same sky colour. Now that is a very obvious conclusion. You will always note the greatest possible distinction between the colour of the pure sky and of the clouds. A favourite *sky* colour in sunsets is green. I have seen no green *clouds* except in pictures.

I have noted a few of those pictures this year, which, in my opinion, and I only give it for what it is worth, are remarkable for their truth, or for the absence of it, in different degrees. The numbers are those of the Royal Academy Catalogue, unless otherwise stated:—

Clouds.—Good colour, 351.

Good form, 288, 600.

Good colour and form, 238.

Water.—Good colour, 630, 1029.

Good surface, 682, 759, 1013. New Gallery, 102, 120.

With great deference I must, until convinced to the contrary, hold that much of the colour in the following

¹ Continued from p. 178.

pictures is *impossible*—543, 1028, 176, 192, 515; it is bad in 203, 498, 586, 602, 1044, 1071.

The cloud forms in 498, 536, and 966 are unlike anything I have seen in any quarter of the world.

But cloud is not the only thing we have to deal with. There is a still finer form of aqueous vapour which shows itself as *atmosphere*; its function is to soften distant outlines, to gradually assimilate colours, laying, so to speak, its own upon them, and then, again, to soften even this. So that distant vistas of hills and vales first become blue in prevailing tone, but the most distant ones lose this, and fade to a more neutral tint.

These things this year are admirably rendered in 1130. 293 offends by the impossible hardness of the hill on the right of the picture.

To most of you the terms selective *absorption* and selective *reflection* of colour are familiar; of the latter an admirable study is to be found in 1062. For reflection badly managed, study 145 in the New Gallery. The artist seems to be under the impression that some birds have a special capacity for reflecting colour.

Of special studies of various natural objects, I think the following in the German Exhibition are worth examination: a glacier (287); cloudy moonlight (433); careful study of light-grading (but sun should be more luminous in the latter) (52, 343).

It is not a little singular that we should find such a close association between bad cloud forms and bad colour. It was a true instinct which led Mr. Ruskin to treat of these matters in his "Modern Painters," but why did he not go further into the real basis—the real grit of it all, instead of confining himself to the mere fringe of these great subjects? It was, I expect, because the possible connection between science and art was less recognized then even than it is now. But is it too late? No one could touch the questions still with more sympathy than Mr. Ruskin.

But to come back to the pictures. Almost, if not quite as good as 600, is No. 50 in the German Exhibition. We find in 630 a careful study of colour. The most wonderful colour which can be got on nearly still water is that you sometimes see at sunrise or sunset with a good green or yellowish sky near the horizon, and a perfectly blue sky overhead. In that case every unit of the surface (every undulation) will reflect to your eye a certain amount of horizon-light and a certain amount of blue sky, and the total result will be a sea of molten steel. Another point in this connection is this: if your surface is even, you can get a reflection of this kind from several surfaces besides water. I was in Egypt last winter, and I saw a wonderful sunset, looking out from the little quay at Ismailia. The sand of the desert lay beyond and round the water in the foreground, which was more or less bluish; the lake, in fact, is bounded by sandbanks of no great elevation, the canal coming in at one end and running out at the other.

In the day-time in full sunshine the sand is yellow, as yellow as it can be, and at sunset it is grey-white. There is nothing very remarkable in the sky, but the intense blue in the sky overhead. There is no aqueous vapour to absorb, and therefore there is no colour. But wait for the after-glow! when you get sunlight, reflected from the clouds or sky, which reaches your eye after two transmissions through the lower air; then you can get colour, and you do get it. What you see is the most exquisite violet halo, and the colours with which we are familiar here more or less; but the striking thing is the intense violet halo in the sky, and the warming up of colour till the sunset place is reached. Well, now, what is the effect of that upon the landscape? Everything is turned green, for the simple reason that the only constituent common to the colour which reaches, and is reflected most readily by, the sand, is the tint of green: the sands change, as if by magic, into a wonderful chlorophyll green. Now, I venture to think that the artist who endeavours to work out problems of

this kind will be more likely to paint a beautiful picture than the one who copies nature merely, and this brings me into strict harmony with the Academy motto. It seems to me that physical science may in this way, if associated with the study of art, give us new possibilities in the art future that will transcend anything that we know of now, and the time will certainly come, ultimately, when the highest art will result from the study of natural science and the science of the human form.

Seeing that already artists spend years in the study of only one part of the field of observation, they must surely in time come to the conclusion that it would be better to annex other branches.

It would not be right if I concluded what I have to say without calling attention to the important remarks made by Mr. Briton Rivière, on science in relation to painting, at the Edinburgh Art Congress:—

"Whatever may have been done in other lines of human energy during the Victorian age, there can be no question that its most remarkable achievements, both theoretical and practical, have been those of science. . . . The art of the painter has not escaped its influence. On one side, and a very important one—that of realism—the side which furnishes the language—*i.e.* the signs and symbols which express the idea of the artist—there is a wide front open to the influence of science; and on that side art has not been slow or unwilling to follow the advice of science, or ungrateful for the valuable help it has afforded. According to my theory, this supremacy of science would have influenced art under any circumstances, but it has been able to do so through the very method and language of art itself.

"Will this influence help or retard the influence of art? My answer is, it may do either, according to the manner in which it is received and used by the artist. If the painter resolutely holds the belief that painting is a language, and a work of art the expression of an idea, and uses science, and all that it has discovered and teaches, to enable him better to understand his signs and symbols, *viz.* the material facts of nature, so that by means of them he may express himself correctly, just as a writer has behind him the philologist to busy himself about the derivation and meaning of words, and the grammarian to show him how to place these words so as to produce the meaning he requires—if, I say, the painter so receives and uses the knowledge and appliances of science, then I think the cause of art will be much advanced by science, and works produced under its influence will be stronger and richer than they could possibly have been without it. On the other hand, if the painter allows this scientific knowledge of the material or realistic part of his work to obscure the purely artistic or ideal part of it, to obscure instead of to intensify the *idea*; and if, carried away by the material wonders of the 'thing' which science has unfolded, he forgets the 'thought' altogether, then assuredly, however true he may have shown himself to be to the cause of science, that of art will suffer at his hands—indeed, may be lost altogether. For I feel sure that most of my brother artists will agree with me that it is possible for a picture to be scientifically true and have no art at all in it: and, on the other hand, to contain several scientific blunders and yet be a great work of art."

It will be seen, then, that I have ventured to-day to preach no new doctrine to you: even my gloss on the Academy motto is endorsed by Mr. Briton Rivière.

But I can go further than this, and quote Prof. Helmholtz in support of the gloss. You should all read his admirable lecture "On the Relation of Optics to Painting."¹ In it he remarks, "The artist cannot transcribe Nature: he must translate her;" and he adds, "This translation may give us an impression, in the highest

¹ "Popular Scientific Lectures," Helmholtz, 2nd Series, p. 135. (Longmans, 1881.)

degree distinct and forcible, not merely of the objects themselves, but even of the greatly altered intensities of light under which we view them. . . . Thus the imitation of Nature in the picture is at the same time an ennobling of the impression on the senses."

Let me congratulate you on the fact that here, at all events, the importance of physical science in its relation to art is not forgotten. J. NORMAN LOCKYER.

LUMINOUS CLOUDS.

IN an article contributed to NATURE on November 20, 1890 (vol. xliii. p. 59), Herr O. Jesse (of the Royal Observatory of Berlin) gave an account of his observations of luminous clouds. He has recently submitted to the Prussian Royal Academy of Sciences a record of later work; and, as the subject is one of considerable interest, it may be worth while to translate his paper.¹

With regard to the results, already briefly noted, obtained in the summer of 1890, I have now to report more precisely, that with the help of the grant made by the Academy of Sciences we were able, during the period when the phenomenon appeared, to secure a collection of photographs which afford rich material for study.

On this as on previous occasions the clouds were visible only between the end of May and the beginning of August. They appeared for the first time, in 1890, on May 26; for the last time—and then there was only a feeble trace of them—at the beginning of August. The phenomenon, therefore, was seen within nearly four weeks of the summer solstice—before and after it—but chiefly after it.

Since my last report, I have received confirmation of the statement that the time when the phenomenon appears in the southern hemisphere has a corresponding relation to the summer solstice there. Unfortunately, however, more precise facts with regard to place, &c., in the southern hemisphere, are still lacking.

During the period between May 26 and July 24, 1890, we obtained altogether 180 photographs of luminous clouds at Steglitz, Rathenow, and Nauen, and at the Observatory of Urania, Berlin. Of these photographs, 75 are suitable for the determination of height, inasmuch as they were secured at the same time in at least two different places. Thirty of the photographs may be used for the determination of the speed and direction of the movements of the clouds, because their representations of the clouds were taken at proper intervals at one and the same place. The remaining photographs are adapted for investigations relating to the dimensions of the clouds and their structure.

The phenomenon was again less bright than it had been in the preceding year. Only when the atmosphere was exceptionally transparent was there an approach to the former brilliancy. The aggregations of these masses of particles are obviously becoming thinner, as may also be perceived from the more distinct appearance of certain relations of structure, like the ridge and rib formations (wave formations) mentioned in my last report. Formerly these were concealed by superposition and apparent interference of a greater richness of analogous strata; now the characteristic lines of the configurations consisting of these ridge and rib formations present themselves more simply and in greater isolation.

It has now been proved more successfully than before that the ridges or longitudinal strips lie parallel to, while the ribs or cross strips are almost at right angles to, the direction of the movement of the entire cloud. Further, we made on different days several series of measurements

of the distances of the ribs (wave-crests) from one another with the following groups of results:—

Mean value of the distances of	9 wave-crests	Kilom.
"	10	8.3
"	"	9.9
"	10	8.4
Average	...	8.9

Especially striking, last summer, was the difference between the clearness with which the clouds appeared in the morning hours, and that with which they appeared at the corresponding times before midnight.

With regard to the height of the luminous clouds in the summer of 1890 the measurements, so far as they were definitely calculated, gave the mean value of 82 kilom., agreeing almost exactly with the value of nearly 83 kilom., deduced from my photographs of 1889.

The persistence from year to year—now for the first time shown with sufficient accuracy—of the distance, and therefore of the position of the level surface of the phenomenon, would alone deserve to be recorded as a scientific fact of great importance.

As for the speed and directions of the movements, it was again found that the chief component of the movement was directed from east to west, and amounted to nearly 100 metres in the second, while the speed of the revolution of the zone of the earth above which the clouds were placed is about 240 metres in the second from west to east.

There was also a smaller and variable component in the direction of the meridian. This was directed from north to south at the times at which we have hitherto obtained tolerably secure determinations of movement.

The points of view from which the phenomenon of luminous clouds, on the ground of the observations hitherto made, is to be regarded, are already numerous. There is still, however, a wide field for research in connection with the questions, What are the forces which make the phenomenon appear chiefly in the morning hours? and, What is the nature of those forces which cause the movement of the clouds to be mainly from the north-east, and drive them from the northern to the southern hemisphere and back again? Then the question as to the height of the phenomenon in different latitudes is probably of great importance for the constitution of our atmosphere; and not less interesting is the question relating to the material of which the luminous clouds are composed. Unfortunately the interest taken by the scientific world in this remarkable phenomenon is in general so small that during the short time the phenomenon will probably present itself we can scarcely expect to obtain for these questions answers that shall be to any considerable extent satisfactory.

WILHELM EDUARD WEBER.

THE venerable physicist, Wilhelm Eduard Weber, whose death on June 23 we shortly announced last week, was born at Wittenberg on October 24, 1804, the second of three sons of Michael Weber, Professor of Positive Divinity at Wittenberg. He studied at the University of Halle, where Schweigger was then Professor of Physics; he took his Doctor's degree in 1826, became Privatdocent in the following year, and Professor-Extraordinary of Physics in 1828. In 1831 he was called to Göttingen to succeed Johann Tobias Mayer in the Chair of Physics, and remained there till 1837. Among other results of the death in this year of King William IV., there came about serious changes in the University of Göttingen. Queen Victoria being excluded from the throne of Hanover, by the operation of the Salic law, her uncle, Ernest Augustus, Duke of Cumberland, became King of Hanover. This prince held high views as to the

¹ "Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin," 1891, xxvi. Sitzung der physikalisch-mathematischen Classe, vom 28 Mai. "Untersuchungen über die sogenannten leuchtenden Wolken," von O. Jesse, Steglitz.